Midterm Project Description Report

For Contract No.
DACA42-03-C-0040

Title:
Proton Exchange Membrane (PEM) Fuel Cell Demonstration Of Domestically Produced PEM Fuel Cells in Military Facilities

Submitted To:
US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY02

Submitted by:
DTE Energy Technologies, Inc.
37849 Interchange Drive
Farmington Hills, MI 48335

For Project Located At:
Selfridge Air National Guard Base, Michigan

February 10, 2004

Executive Summary

DTE Energy Technologies (Contractor) and Plug Power Inc. (Manufacturer) has installed and is monitoring and maintaining two (2) CHP Fuel Cell Systems at the Selfridge Air National Guard Base, Michigan (Site Host) for a period of one year (Operating Period) with an option to extend the operation of one or more of the CHP Fuel Cell Systems to be offered the Customer at the end of the one year Operating Period.

The objective of this project (Project) is to plan, install, and operate CHP Systems in a military base environment, generating electricity and heat to support base facilities. The facility has been selected to best demonstrate CHP Systems use in military facilities in a configuration that offers technology transfer and demonstrates replicablity to similar facilities at other Department of Defense facilities. Analysis of energy savings is not a stated objective of this project.

Installation and commissioning of systems were completed on November 26, 2003. The systems are located at the New Base Fire Station, Building 859. The new base Fire, Crash, and Rescue station at 28000 George Avenue in the final stage of completion is a large facility that will provide Crash and Rescue capability for the Base and Airfield in the surrounding Macomb County Area. The mechanical systems at this facility are of an industrial nature.

Contractor has provided the site planning, preparation and installation of CHP Systems. Operations and maintenance support, and decommissioning of each of the CHP Systems installed is in progress and will last until November 25, 2004. The Manufacturer is responsible for CHP System manufacture, delivery, and technical support to the Contractor.

The 5kW CHP Systems, manufactured by Plug Power Inc. incorporate combined heat and power capability to provide electricity, allow recovered waste heat from the CHP Systems to provide heat for heating or domestic hot water. The system operates using natural gas as a fuel and in grid parallel mode to provide supplemental on-site power and usable heat to specific facilities. Additionally, the CHP Systems incorporate standby capability to allow the units to supply power to segregated critical loads during periods of electric utility grid (Grid) outage.

The point of contact at Selfridge ANG is Mr. Michael Anderson who can be contacted at (586) 307-5402.

Table of Contents

Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

Combined Heat and Power Fuel Cell System (CHP System) Demonstration at Selfridge Air National Guard Base, Michigan (East North Central Region)

2.0 Name, Address and Related Company Information

DTE Energy Technologies (Contractor)
37849 Interchange Drive
Farmington Hills, Michigan 48335

Data Universal Numbering System (DUNS) Number: 111996430
Commercial and Government Entity (CAGE) Code: 1UM49
Taxpayer Identification Number (TIN): 383394820

DTE Energy Technologies, a wholly owned subsidiary of DTE Energy, whose primary business focus is establishing a leadership position in the emerging distributed generation industry. Contractor is uniquely positioned to offer one-stop sales, engineering, and service to energy customers using a best of breed portfolio of new technology products and control services.

3.0 Production Capability of the Manufacturer

CHP Systems are manufactured at Plug Power's Latham, New York manufacturing facility. This facility, which opened in February 2000, is comprised of 50,000 square feet of dedicated production and production test facilities. Manufacturer employs approximately 100 personnel in its production areas. The production processes are designed around the principles of Lean Manufacturing, and use the Toyota Production System as a model. As such, planning and production is via a "pull system" that is, systems are produced only as orders pull demand for product through the production system. Lead-time for delivery is between eight (8) and twelve (12) weeks for large orders, smaller orders (less than ten) can be fulfilled immediately. Current production capability allows for the manufacture of approximately five (5) units per week with the ability to significantly increase this rate.

Manufacturer agrees to provide a minimum of two (2) CHP Systems to support this Program and to provide warranty and technical support to Contractor to support the operation of the CHP Systems as specified in this proposal.

Plug Power contact information:
Mr. Scott Wilshire
Director, Marketing Engagement
968 Albany Shaker Road
Lathum, NY 12110

Tele: 518.782.7700 ext. 1338
Email: scott_wilshire@plugpower.com

4.0 Principal Investigator(s)

Ted Bregar
Director, Business Development
DTE Energy Technologies, Inc.

Tele: 248.427.2349
Fax: 248.427.2265
Email: bregart@dteenergy.com

5.0 Authorized Negotiator(s)

Ted Bregar
Director, Business Development
DTE Energy Technologies, Inc.
Tele: 248.427.2349
Fax: 248.427.2265
Email: bregart@dteenergy.com

Peter Gibson
Vice President, Sales
DTE Energy Technologies, Inc.
Tele: 248.427.2274
Fax: 248.427.2265
Email: gibsonp@dteenergy.com

6.0 Past Relevant Performance Information

DTE Energy Technologies (Contractor)

Detroit Metropolitan Wayne County Airport
Romulus, Michigan 48242
POC: Mr. Robert Murphy, (734) 942-3556
Project Title: Midfield Terminal 17MW Co-generation Project
Contract Identification Number: N/A

- Contract Completion Date: February, 2002
- Contract Amount: $17M

Ann Arbor News
340 E. Huron Street
Ann Arbor, Michigan 48106
POC: Mr. David Sharp, (734) 994-6804
Project Title: 2MW Standby Generation
Contract Identification Number: N/A

- Contract Completion Date: November, 2001
- Contract Amount: $1.5M

Michigan Public Services Commission
Commission Operations Division
6545 Mercantile Way
Lansing, MI 48909

POC: Dr. Nicholas Nwabueze, 517.241.6137
Project Title: Michigan Energy Efficiency Grant PSC-03-02
Contract Identification Number: PSC-03-02

- Contract Completion Date: September, 2003
- Contract Amount: $395,000

Plug Power Inc. (Manufacturer)

Long Island Power Authority
333 Earle Ovington Blvd
Suite 403
Uniondale, NY 11553
POC: Mr. Daniel Zaweski, (516) 719-9886
Project Title: Fuel Cell Demonstration Program
Contract Identification Number: N/A

- Contract Award Date: May 15, 2001
- Contract Amount: $7M
- Contract Award Date: February 22, 2002
- Contract Amount: $3.6M

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399
POC: Mr. James Foster, (518) 862-1090 x3376
Project Title: Fuel Cell Demonstration Project
Contract Identification Number: No. 4870 - ERTER - BA - 99

- Contract Award Date: January 25, 1999
- Contract Amount: $3M

National Fuel Gas Corporation
10 Lafayette Square
Buffalo, NY 14203
POC: Mr. Rob Eck, (716) 857-7711
Project Title: Residential Fuel Cell Demonstration Project
Contract Identification Number: N/A

- Contract Award Date: February, 2002
- Contract Amount: $200K

7.0 Host Facility Information

Selfridge Air National Guard Base is a joint military community located 22 miles east of Warren, Michigan, on Lake St. Claire. As the last base in Michigan, Selfridge supports a population of 50,000 people. Selfridge Air National Guard Base is defined as the Site Host Facility. The base is home to both U.S. Air Force and U.S. Army garrisons. The electricity provider for Selfridge is Detroit Edision, natural gas is provided by CMS Energy.

Appendix 1 of the Initial Report contains pictures of the facility's main gate.

8.0 Fuel Cell Installation

The contractor along with the Air Force Site Host Facility personnel identified the new Fire and Rescue Building 859 the location for this project. Fuel Cell #1 and Fuel Cell #2 are located outdoors and adjacent to the existing standby generator. This location is electrically and mechanically close to all the utilities needed for the installation. The Fire and Rescue building is 8000 square feet and carries approximately 24kW of load which calculates to approximately 17,280kWH/month. The two units where commissioned on November 26, 2003 and are currently producing 4kW each for a total of 8kW which calculates to approximately 5,760kWH/month. The units are base loaded and are 25% efficient electrical and 55% efficient with full CHP heat recovery. The operating procedure is as follows; the units are pre-programmed to run at 4kW each into the building, for a total base load of 8kW. Monitoring is done via telephone modem and is communicated to the DTE Energy Technologies SOC center in Farmington Hills Michigan. Fuel cell operating procedure in relation to the existing diesel standby is as follows. Upon the loss of utility the Auto Transfer Switch (ATS) starts the diesel standby generator and also toggles a relay which takes the fuel cells offline. After the diesel standby is up and running, the ATS switches the building load onto the generator. The fuel cell will remain offline until two events take place. #1 – utility returns and ATS returns to normal. #2 – Air Force Site Host Facility personnel reset the lockout relay manually (pushbutton) in the mechanical room.

Appendices 2 and 3 of Initial Project Report contain photographs.

9.0 Electrical System

The two fuel cells have independent feeder cable to an existing electrical panel in the Fire and Rescue mechanical room. These feeders are single phase 120VAC 50A rated. Each fuel cell has a 50A molded case circuit breaker installed in an existing electrical panel in the Fire and Rescue mechanical room. The connected power output is 10kW and provides a portion of the base load for the Fire and Rescue building. The fuel cells are grid dependent and continuously provide electrical power. If utility connection is lost the fuel cells go offline.

Appendix 4 of Initial Project Report contains drawings and photographs.

10.0 Thermal Recovery System

The fuel cells thermal output is connected to a common header, which then travels into the Fire and Rescue mechanical room. This thermal loop in constructed of 1" copper tubing and has an independent pump to circulate the glycol/water mixture. The loop is connected to a plate and frame heat exchanger rated at 56Mbtu/Hr at 130 degrees F. This heat exchanger is in the return loop of the existing boilers and is load balanced via a manual valve. This Plate and Frame heat exchanger is used to preheat the water entering the boilers. The existing return loop temperature is 160 degrees F with a 20 degree delta 'T'. The thermal output of the two fuel cells operating at 4kW each for a total of 8kW is 42Mbtu/Hr. The thermal output is continuous to supplement the existing heating system. The system also includes solenoids and an aqua stat to stop the circulation of the thermal recovery system in the event the building's system reaches a temperature such that thermal recovery is not required.

Appendix 5 of Initial Project Report contains drawings and photographs.

11.0 Data Acquisition System

Two systems acquire data from the fuel cell. The first is an on board Mitsubishi processor that is in the System and Reformer Controller (SARC). This continually monitors the unit for E-stop and over 100 different conditions as well as any abnormalities. E- Stop condition will exist for the following conditions. Cabinet flow switch FS1, cathode air flow falls low, high gas pressure, gas leaks methane FG1 and hydrogen HS1 , cooling loss to electronic controls PRES2, loss of communication of the SARC and inverter, various system and high cabinet temperatures and humidifier overpressure. If any of these conditions or any other anomalies exist the unit will immediately shut down. Upon shutdown 15 minutes of data is stored and sent to Plug Power for analysis via the on board modem. An E-mail is than generated and sent from Plug Power to the authorized service personnel.

The second data acquisition is the System Operation Center (SOC). SOC remotely monitors and controls distributed assets via the internet, public switch networks and private circuits. There are 3 levels of SOC operation available: asset monitoring only, monitoring / dispatching and, monitoring / dispatching / energy trading. SOC hardware is Commercial off the Shelf (COTS) with the software using Extensible Mark-up language (XML) Remote Procedure Call (RPC). In this particular application SOC monitors the fuel cell grid voltage, current, frequency and kilowatts along with the following; error codes, battery amps, battery voltage, battery temperature and system state. Data can be viewed from the internet and is monitored daily by a SOC operator. SOC will send a text message or e-mail or a phone call if the unit shuts down.

12.0 Fuel Supply System

The fuel system for the two fuel cells consisted of connecting to the existing gas service for the Fire and Rescue building. The two fuel cells consume approximately 210 CFH at full load.

13.0 Installation Costs

Direct Material	
Fuel Cells	$110,000
Misc Equip	6,000
Transaction Costs	5,000
Service and Maintenance Parts	60,000
Installation and Interconnection	
Engineering	8,728
Installation	77,643
Equipment monitoring	5,000
Equipment removal	4,000
Operation	47,300
Site Restoration	5,500
Total	329,171

14.0 Acceptance Test

Plug Power's *Installation and Operation manual* contains information which was followed for the initial operation of the Fuel Cells. The following describes some of the major steps described in the above manual.

Fuel Supply

- Purge and check for any leaks
- Adequate fuel pressure

DI panel

- DI ratio 6:1 or 7:1
- Min 40 psi max 120 psi

Electrical

- Install stack
- Connect battery

Appendix

INSPECTION REPORT

EQUIPMENT INSPECTED

Location	SANG	**Model**	GEN sys 5
Contact:		**System Serial #**	SU01B00000194
Address:		**Stack Serial #**	S001B000000
City:	Mt Clemens	**Technician:**	Kevin Wisniewski
State/Province:	MI.		
Country:		**Zip Code:**	

System Status

Error code		**Error code**			
Time Unit Shutdown		**Start Date:**	11/27/2003	**Time Started**	7:30
Date unit Shutdown		**Date completed**	11/27/2003	**Time completed**	15:00

OPERATION CHECKS

Run Hours	1	Stack run hours	0.5	KW Hours	
Fuel Consumption		Fuel CU FT	0	Line RMS Voltage	123.5
Line RMS Current	39.1	Inverter Frequency	60	Average AC Power	120
Grid Voltage	123.2	Grid Current	7.4	Grid Frequency	60
Grid Power	-872	Fuel Cell DC Voltage	49.6	Fuel Cell Current	131.6
Battery Voltage	49.1	Battery Current	4.2	Low Cell #	85
Low Cell Voltage	0.71	H2 stoich		D I level	
System Efficiency		Electronic Compartment Temp			

CURRENT REPAIR INFORMATION

Symptoms Displayed	Parts Replaced/Service Performed
1 commissioning unit	1 install stack
	install therminol, gylcol commission di water system
2	2

COMMENTS

Technician Signature _____ **Work order #** _____

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INSPECTION REPORT

EQUIPMENT INSPECTED

Location	SANG	**Model**	GEN sys 5
Contact:		**System Serial #**	SU01B00000195
Address:		**Stack Serial #**	S001B000000
City:	Mt Clemens	**Technician:**	Kevin Wisniewski
State/Province:	MI.		
Country:		**Zip Code:**	

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Error code		**Error code**			
Time Unit Shutdown		**Start Date:**	11/27/2003	**Time Started**	7:30
Date unit Shutdown		**Date completed**	11/27/2003	**Time completed**	15:00

OPERATION CHECKS

Run Hours	1.2	Stack run hours	0.5	KW Hours	
Fuel Consumption		Fuel CU FT	0	Line RMS Voltage	123.5
Line RMS Current	39.1	Inverter Frequency	60	Average AC Power	4855
Grid Voltage	124.7	Grid Current	7.4	Grid Frequency	60
Grid Power	-872	Fuel Cell DC Voltage	49.8	Fuel Cell Current	131.8
Battery Voltage	49.1	Battery Current	4.4	Low Cell #	88
Low Cell Voltage	0.73	H2 stoich		D I level	
System Efficiency		Electronic Compartment Temp			

CURRENT REPAIR INFORMATION

Symptoms Displayed	Parts Replaced/Service Performed
1 commissioning unit	1 install stack
	install therminol, gylcol commission di water system
2	2

COMMENTS

Technician Signature _____ **Work order #** _____

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FUEL CELL COMMISSIONING CHECK LIST
DTE Energy Technologies, Inc.

37489 Interchange Dr.
Farmington Hills, Mi. 48335
Phone: 248-427-2352 Fax: 248-427-2371

Serial # SU01B000000194 **Model** # Gen SyS 5

Initial Installation & Pre-start Checks

	Fuel System:		**Cooling System:**
X	Natural Gas	X	Glycol
X	Manual Shutoff Valve		
X	Solenoid Valves	X	Proper air circulation
X	Dry Fuel Strainer / Drip Leg	X	Therminol
X	Flexible Fuel Connection	X	Plate and frame heat exchanger
X	Gas Available		
	Battery		**Exhaust System:**
X	Proper battery size	X	Exhaust extension installed
X	Electrolyte		
X	Correct polarity		**General Inspection**
X	Battery charger wiring	X	Wiring
X	Proper layout for electrical & fuel conduits	X	Hoses & clamps
X	Generator secured to level surface	X	Clearances
X	Proper Size Breakers	X	Supports
X	Proper AC load wiring		
X	Proper AC generator wiring		
X	Proper AC normal wiring		
	Control Wiring – **Must be in separate Conduit from AC wires.**		
	AC Leads:		
X	*__ Separate from control wiring		**DI water**
X	*__ Terminated correctly	X	Filters installed
X	Building Utility service is hooked up	X	RO filter purged per Plug Power specification’
X	All electrical termination points properly Tighten	X	Ratio within specifications
		X	Solenoid 2 wired

Recommendation or Modifications before Unit is started for the first time

_____

	Start & Warm-Up Period		**Inspect with Load**
X	Battery charging rate	X	Amps
X	Exhaust stack safe & Clear	X	Voltage 120
X	Field breaker "on"	X	Frequency _60__ Hz.
X	Check for unusual noise & vibration	X	Unusual noises & vibrations
X	coolant level therminol		
X	Glycol level		

Comments

_____

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_____

Initial Start-up, System Checkout and Test Record

Warranty start date: 11-27-2003 Initial start date: 11-27-2003

Sold To:

Project Name & Address:

Selfridge Air National Guard

Service Inspection:

Performed By: Kevin Wisniewski

_____

D/TECH Date

FUEL CELL COMMISSIONING CHECK LIST
DTE Energy Technologies, Inc.
37489 Interchange Dr.
Farmington Hills, Mi. 48335
Phone: 248-427-2352 Fax: 248-427-2371

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X	Correct polarity		**General Inspection**
X	Battery charger wiring	X	Wiring
X	Proper layout for electrical & fuel conduits	X	Hoses & clamps
X	Generator secured to level surface	X	Clearances
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Selfridge Air National Guard

Service Inspection:

Performed By: Kevin Wisniewski

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D/TECH Date